Faculty of Engineering
Department of Textile Engineering

REPORT ON
APPLICATION OF INDUSTRIAL ENGINEERING IN SEWING FLOOR OF A KNIT GARMENT

Course Title: Project (Thesis)
Course Code: 4214

Submitted By

AbdurRazzak	**ID: 113-23-2637**
Md.Sadrul Amin	**ID: 113-23-2769**

Supervised By

Md. Abdullah Al Mamun
Assistant Professor

This Report Presented in Partial Fulfillment of the Requirements for the Degree of Bachelor of Science in Textile Engineering.

Advance in Apparel Manufacturing Technology

July, 2015

DECLARATION

We hereby declare that, this project has been done by us under the supervision of Abdulla Al-Mamun, Assistant professor, Department of Textile Engineering, Daffodil International University. We also declare that neither this project not any part of this project has been submitted elsewhere for award of any degree or diploma. We have submitted this project to knowing about industrial engineering and how much we can learn during working on this project.

AbdurRazzak	ID-113-23-2637
Md.Sadrul Amin	ID-113-23-2769

Department of Textile Engineering

Approval Sheet

This research entitled **''Application of Industrial Engineering In sewing Floor of a knit Garments"at Daffodil International University, A. Y. 2015**'' prepared and submitted by Abdur Razzak & Md. Sadrul Amin in partial fulfillment of the requirement for the degree of BACHELOR OF SCIENCE IN TEXTILE ENGINEERING has been examined and hereby recommended for approval and acceptance.

AAM

Supervisor

ACKNOWLEDGEMENT

First of all we express our gratitude to our Almighty for blessing, approval, protection, mental power & wisdom in all aspects of our lives & also for giving us the opportunities to complete the industrial attachment successfully. Alhamdulillah.

We pay gratitude to the people of H.R TEXTILE MILLS LTD. Those who have made significant contributions in achieving hands of knowledge.

Daffodil International University has given us the opportunity to perform the internship with H.R TEXTILE MILLS LTD.

We are deeply indebted to our supervisor Mr. Abdullah AI-Mamun, Assistant Professor, Department of Textile Engineering, Daffodil International University. Whose help, suggestions & encouragement helped us in all the time to research and writing the report.

We would like to pay special thanks to Prof. Dr. MahbubulHaque, the Head of the Textile Department, Daffodil International University, for giving us the opportunity to accomplish the attachment. We also thanks to Prof. Dr. Mahbub-UL HaqueMajumdar, Founder & Dean of FSIT and also to Professor Dr. M.ShamsulAlam, Dean of Faculty of Engineering, Daffodil International University for their stimulating support and encouragement.

We would like to express our sincere gratitude to Human Resource Manager of H.R TEXTILE MILLS LTD. Who has allowed us to work in the organization.

We would like to thanks the Chairman, Managing Director, General Manager, Production Manager, Merchandising Manager, Administration Manager for assisting us to gather information about various processes and giving us scope for doing Internship in the factory as well as for giving scope to work in their respective section.

DEDICATION

We know that every challenging work needs self-efforts as well as guidance of elders especially those who are very close to ourheart.We want to dedicate our thesis paper to our sweet and loving Father & Mother also some of our beloved friend “R & M” whose affection, love, encouragement, hard-work& prays of days & night make us able to complete this thesis.

No doubt about that wealso want to dedicate this thesis paper to all of our dearest & hardworking teachers who always encourage, support & suggested us to make a better thesis paper.

ABSTRACT

This project is on "Application of Industrial Engineering in a knit garments sewing floor". Traditionally operated garment industries are facing problems like low productivity, longer production lead time, high rework and rejection, poor line balancing, low flexibility of style changeover etc. These problems were addressed in this study by the implementation of lean tools like cellular manufacturing, single piece flow, work standardization, just in time production, etc. After implementation of lean tools, results observed were highly encouraging. Some of the key benefits entail production cycle time decreased by 8%, number of operators required to produce equal amount of garment is decreased by 14%, rework level reduced by 80%, production lead time comes down to one hour from two days, work in progress inventory stays at a maximum of 100 pieces from around 500 to 1500 pieces. Apart from these tangible benefits operator multiskilling as well as the flexibility of style changeover has been improved. This study is conducted in the stitching section of a shirt manufacturing company. Industrial Engineer plays an important role to solve each problem which one we mentioned above.

Table of Contents

1.0 INTRODUCTION

Industrial engineering is the branch of engineering that involves figuring out how to make or do things better. Industrial engineers are concerned with reducing production costs, increasing efficiency, improving the quality of products and services, ensuring worker health and safety, protecting the environment and complying with government regulations.

They "work to eliminate waste of time, money, materials, energy and other commodities," according to the Institute of Industrial Engineers. For example, industrial engineers may work to streamline an operating room, shorten a roller-coaster line, make assembly lines safer and more efficient, and speed up the delivery of goods.

We can see I.E at a glance;

I.E = Production ↑ C ↓ Proper used of all elements ↑ Efficiency↑ Profit ↑

1.1. Objectives of this thesis:

- ✓ To know about industrial engineering.
- ✓ To know how to increase productivity by using best methods and most efficient use of resources.
- ✓ To find out how to reduce value adding activities.
- ✓ To know how to establish methods for improving the operations and controlling the production costs.
- ✓ To know how to develop process for reducing costs.

1.2. Scope of this thesis:

- ✓ Study, measure & improve the way of individual performance.
- ✓ Design and install a better system to co-coordinating each other.
- ✓ Specify, predict and evaluate the works.

1.3. Limitation of this thesis:

- ✓ It is a time consuming process.
- ✓ It is a costly procedure.
- ✓ Difficult to reduce bottleneck process.
- ✓ Difficult to give rating and allowance of workers.

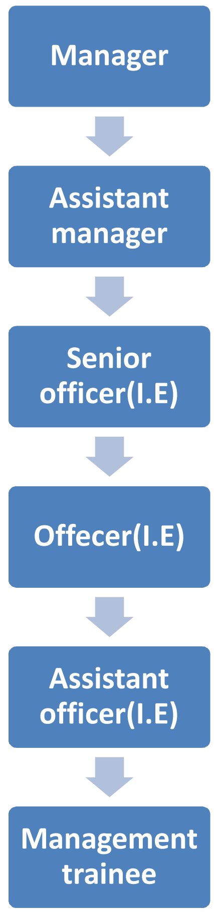
2. LITERATURE REVIEW

When there was no industrial engineering department that time export our production with lot of difficulties. That time line efficiency was less, time wastage, bottleneck process was more so the production quality wasn't good. But after coming the concept of industrial engineering in 1979, we can solve this problem.

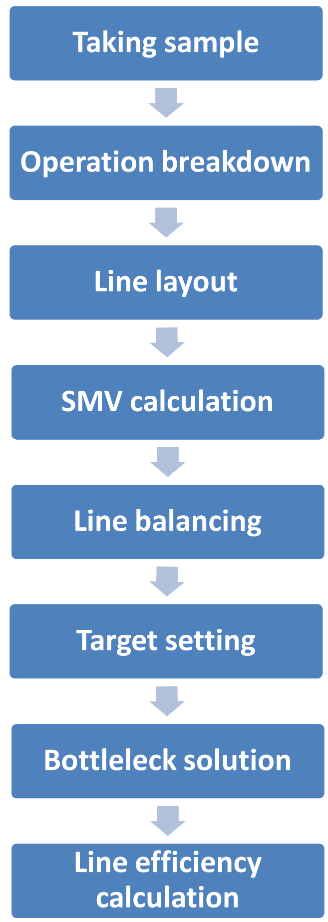
Industrial engineers are responsible for designing integrated systems of people, machines, material, energy, and information. Industrial engineers figure out how to do things better. They engineer processes and systems that improve quality and productivity. They work to eliminate waste of time, money, materials, energy, and other resources. This is why more and more companies are hiring industrial engineers and then promoting them into management positions.

On the other-hand industrial engineering is a section in which knowledge of mathematical and natural sciences gained by study, experience and practice are applied with judgment to develop the ways to utilize economically the materials, which we don't find in other sector of garments.

2.1. Organogram of industrial engineering department:



2.2. Flow process of industrial engineering section:



2.3. Functions/responsibilities of industrial engineering department:

- ✓ Operation breakdown.
- ✓ Line layout making
- ✓ SMV Calculation.
- ✓ Line balancing.
- ✓ Individual target, weekly and monthly target setting.
- ✓ Ensure optimum use of machine.
- ✓ Bottleneck solution.
- ✓ Reduce non value adding activities.
- ✓ Line efficiency calculation.
- ✓ Conduct test cutting to see pattern adjustment and find out the problem.
- ✓ Called pre-production meeting after test cutting.

2.4. Industrial engineering formula with example:

- **Observe time =** $\dfrac{\mathbf{C \quad ti}}{\mathbf{N \quad o \;\; c}}$
- **Basic time = Observe time X rating**
- **SMV =** $\dfrac{\mathbf{B \quad ti \quad +(B \quad ti \quad x\,A \qquad)}}{\mathbf{6}}$

Example:

If time for joining a shoulder seam is **14.84, 19.06, 17.35, 17.35, 17.67, 20,99, 18.98,19.10, 18.26, 14.49**seconds & worker rating and allowance is 70% and 15% so find out the observe time, basic time and SMV?.

Solution:

Observe time = $\dfrac{1\ .8\ +1\ .0\ +1\ .3\ +1\ .3\ +1\ .6\ +2\ .9\ +1\ .9\ +1\ .1\ +1\ .2\ +1\ .4}{1}$

$=\dfrac{1\quad .0}{1}$

= 17.80

Basic time = 17.80 x 0.70

= 12.46

∴SMV = $\dfrac{1\ .4\ +(1\ .4\ x\ 0.1\ )}{6}$

= 0.23

- **Line target =** $\frac{\textbf{T \quad m \qquad x 6}}{\textbf{S}}$

Example:

Suppose a sewing line has 30 machines where work 30 operators and 4 helpers. If its SMV is 15.5 so what will be the line target?

Solution:

Line target = $\frac{3 \quad x\,6}{1\ .5}$

= 131 pcs/hr

- **Line efficiency =** $\frac{\textbf{T \quad p \qquad x S}}{\textbf{T \quad m \qquad x w \qquad h \quad x 6}}$ **x 100**

Example:

Suppose a sewing line has 18 machines where work 18 operators and 2 helpers. Its SMV 10 and end of the day it produce 750 T-shirt. If working hour is 8, so find out its line efficiency?

Solution:

Line efficiency = $\frac{7 \quad x\,1}{2 \quad x\,8\,x\,6}$ x 100

=78%

Production: Production means activities it means they provide you resources & you have to convert this resource into product.

Production = Measure / unit of output.

Productivity: Productivity means how speedily products are produce.

- **Pitch time =** $\frac{\textbf{S}}{\textbf{T \quad m}}$

- **Productivity =** $\frac{\textbf{O \qquad (E \quad m \qquad)}}{\textbf{I \qquad (A \qquad m \qquad)}}$ **x 100**

Example:

Suppose 130 piece garments cut fabrics are given in a sewing line. They produce 100 pieces garments per hour. Find out the productivity of this line?

Solution:

Productivity = $\frac{1}{1}$ x 100

= 77%

- **Earn minute = Production x SMV**
- **Available minute = Total manpower x working hour**
- **Individual capacity = $\frac{\mathbf{6}}{\mathbf{O \quad ti}}$**
- **Individual target = $\frac{\mathbf{6}}{\mathbf{S}}$**

Example:

If observe time and SMV for attaching a packet is 30s and 0.44 minute respectively. If operator rating and allowance is 75% and 15% respectively so that what will be the individual capacity and target for this operator?

Solution:

Individual capacity = $\frac{6}{3}$

= 2 pcs/minute

Individual target = $\frac{6}{0.4}$

= 136 pcs/hr.

2.5. Techniques of Industrial Engineering:

Method study:

To establish a standard method of performing a job or an operation after thorough analysis of the jobs and to establish the layout of production facilities to have a uniform flow of material without back tracking.

Time study (work measurement):

This is a technique used to establish a standard time for a job or for an operation.

Motion Economy:

This is used to analyses the motions employed by the operators do the work. The principles of motion economy and motion analysis are very useful in mass production or for short cycle repetitive jobs.

Value Analysis:

It ensures that no unnecessary costs are built into the product and it tries to provide the required functions at the minimum cost. Hence, helps to enhance the worth of the product.

Financial and non-financial Incentives:

These helps to evolve at a rational compensation for the efforts of the workers.

Production, Planning and Control:

This includes the planning for the resources (like men, materials and machine) proper scheduling and controlling production activities to ensure the right quantity, quality of product at predetermined time and pre-established cost.

Material Handling Analysis:

To scientifically analysis the movement of materials through various departments to eliminate unnecessary movement to enhance the efficiency of material handling.

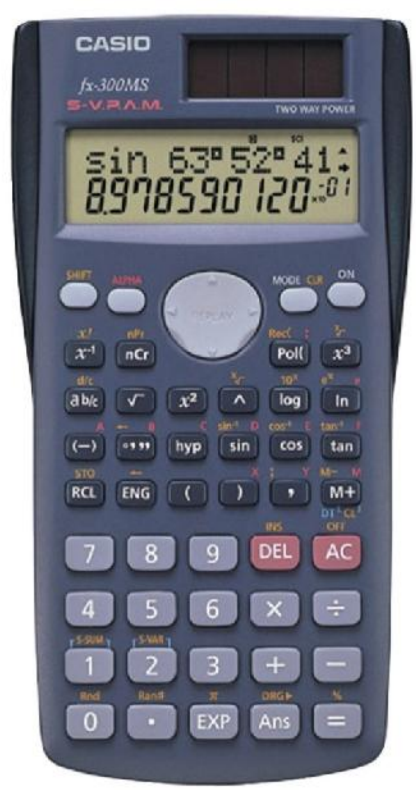
2.6. Equipment used by industrial engineers in the garment industry:

Stop Watch: Measuring observed time at the time of time study.

Measuring Tape: Measuring length of seams and measuring distances.

Digital Camera: Capturing videos for various operations that help in motion analysis of operations.

Calculator: Data calculation and report making.



3. DATA COLLECTION

3.1. SMV:

“”Standard Minute Value””. It’s a standard time for completing a given tasks by using best possible method.

3.1.1. Importance of SMV calculation:

- ✓ Planning for making garments depends on SMV.
- ✓ Line balancing depends on SMV.
- ✓ Costing of garments depends on SMV.

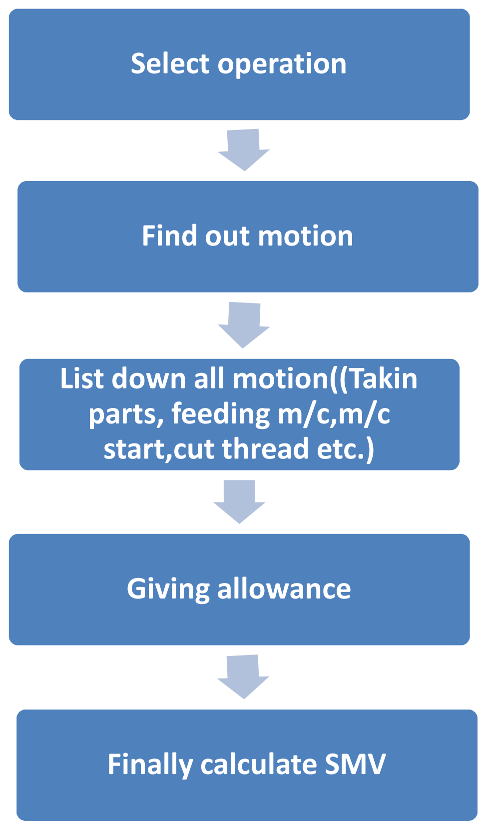
3.1.2. Problem of manual SMV calculation:

- ✓ Rating problem.
- ✓ Exact result doesn’t come because input varies from man to man.
- ✓ Difficult to take cycle time.

3.2. GSD software:

GSD means “General Sewing Data” which is a pre-determine time and motion based time measuring system (PMTS).

3.2.1 Flow process of SMV calculation by GSD software:



3.2.2 Advantage of using GSD software:

- ✓ Easy to calculate SMV.
- ✓ We can get exact result for each operation.
- ✓ Required less time.

3.3. Bottleneck process:

Bottleneck means delay in work suppose input comes faster but next operator cannot provide output smoothly to next operator.

Fig: Bottleneck operation

3.3.1. Way of bottleneck operation identification:

- ✓ Check capacity to each process for each operator.
- ✓ WIP analysis.
- ✓ Visually.

3.3.2. Way of reducing bottleneck operation:

- ✓ Method improvement (At first attach care label, join yoke then loading all parts together).
- ✓ Sharing capacity/work to other operator (Take few pieces from the bottleneck operation to nearby operation which has potentially higher capacity).
- ✓ Add additional manpower or machine.
- ✓ Allocate better operator (A' grade operator is allocated on a high capacity operation).
- ✓ Work extra hour.

3.4. Line balancing:

Proper allocation of machine & sharing of time to each operator equally so that they can get equal time for their operation & can share their work to each operator equally for equal production.

Example:

Suppose pitch time for an operation is 0.20 but for sewing side seam of a T-shirt is 0.35.As pitch time for an operation is 0.20 so for sewing side seam required 2 operators and 2 machines for line balancing. On the other-hand for attaching care label required 0.10 as pitch time for an operation is 0.20 so for line balancing the operator must have done another work such as placket or pocket marking etc. So by this way we can balance a sewing line.

3.4.1. Objectives of line balancing:

- ✓ To eliminate bottlenecks, ensuring a smoother flow of production.
- ✓ To minimize work-in-progress (zero inventory or just-in-time concept)
- ✓ To improve the quality and productivity of the assembled products.
- ✓ To reduce waste of production and delay.

Line balancing

3.4.2. Line balancing provision:

- ✓ Machine should be same.
- ✓ Machine guide and folder should be same.
- ✓ Sewing thread should be same as well.

3.5. Allowances:

Allowances means 100% time so that an operator can earn satisfactory wage. It is determined by a time study. At least 30% allowances are provided into three categories which are given below;

Name of allowance	Allowance percentage (%)
Machine delay(Bobbin,looper,feed,guide)	10
Personal allowance(Personal need,fatigue,sadness,SBS	15
Contingency/uncertain delay	5

3.6. Worker rating:

Rating is a comparison of performance of the worker which is given by visual seen based upon their experience. During time study for industrial engineering needs to record the time of any process to find out the SMV. A slower is performance rate, which will produce fewer pieces per hour, is recorded as a percentage below 100%. A faster performance rate that produces more pieces per hour is recorded as greater than 100%.

3.6.1. When we will give 100% rating of a worker:

- ✓ Fluid motions without hesitation.
- ✓ No false starts or duplications
- ✓ Consistent, coordinated, effective rhythm of work.
- ✓ No wasted actions.
- ✓ Clear attention on the task.

3.6.2. Knowledge of observer for giving accurate rating:

To improve accuracy in rating an operator, observer must have;

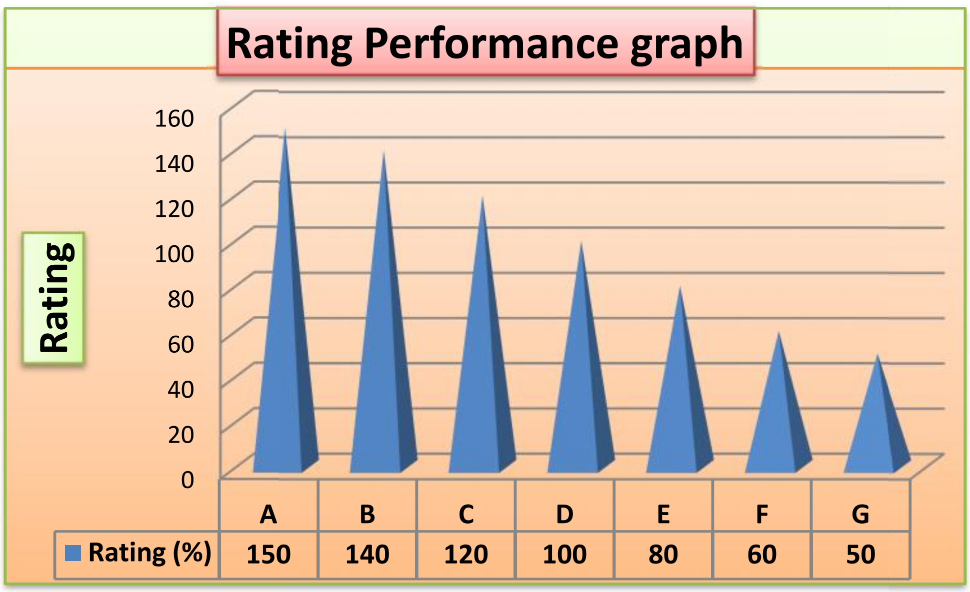
- ✓ Has knowledge of the operation and the specified method.
- ✓ Concentrates on operator motions
- ✓ Eliminates interruption during work.
- ✓ Increasing the number of cycles also increases rating accuracy.

✓ **Performance rating** = $\frac{\text{B} \quad \text{ti}}{\text{O} \quad \text{ti}}$ x 100

Example:

Person	Observe time	Basic time	Rating (%)
A	0.20	0.20	100
B	0.16	0.20	125
C	0.25	0.20	80

3.6.3. Rating performance:



Here, D, E is standard worker rating, A, B, C is fast worker rating & F, G slow worker rating.

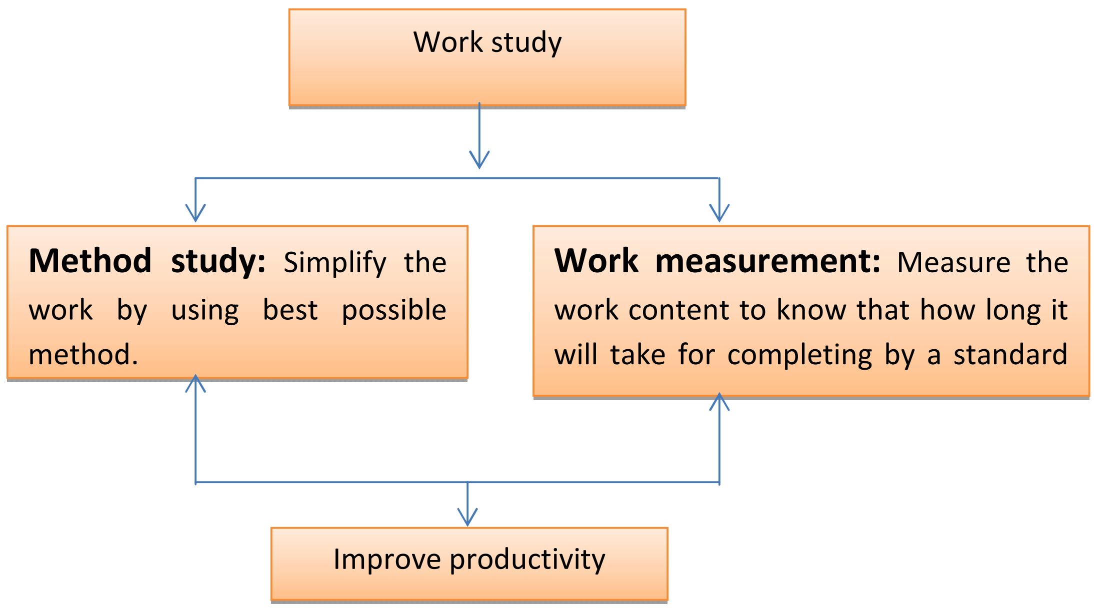
3.7. WORK STUDY

Work study is a systematic technique of method analysis work measurement and setting of time standard that can be ensure the highest productivity by the optimum use of man power, equipment and material.

3.7.1. Objectives of work study:

- ✓ Simplify the task.
- ✓ Increase production efficiency by minimizing the bottleneck of an operation. .
- ✓ Work study helps proper utilizing of man, machine and materials. So we can minimize the leisure time, waste time and by this improve in production will be remarkable.

3.7.2. Ways of work study:



3.8. TIME STUDY

Time study is a method of measuring time by recording the time of a process/operation. An operator does same operation throughout the day. Time study help to define how much time is necessary for an operator to carry out the task at a defined rate of performance.

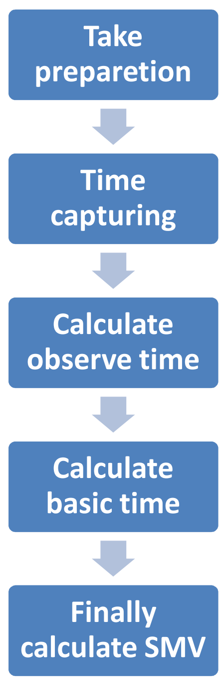
3.8.1. Objectives of time study:

- ✓ Reduce the wastage of time.

3.8.2. Time study tools:

- ✓ A stop watch
- ✓ Time study format
- ✓ One pen or pencil

3.8.3. Time study procedure:



3.9. METHOD STUDY

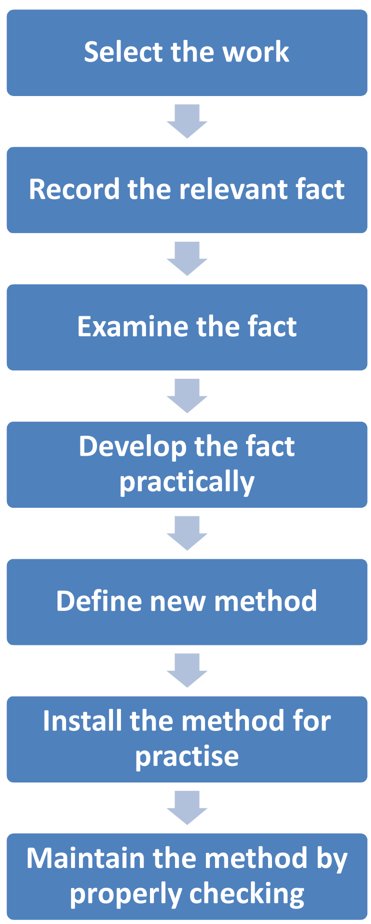
Method study means which method we will use for our work. Method study is essentially used for finding better ways of doing work. It is a technique for cost reduction.

Example: Suppose for making a polo shirt form where we will start, we will start from placket or we will start by joining pocket, shoulder that is method study.

3.9.1. Objective of method study:

1. Improvement of line layout.
2. Improvement in the use of men, materials and machines.
3. Improved flow of work.
4. Optimum output.
5. Wastage reduces.

3.9.2. Method study procedure:



3.10. Operation breakdown: Short sleeve round neck T-shirt

Description: Short sleeve round neck T-shirt

Fabric: Single jersey, 100% cotton, GSM-140

Operation name	Machine type
Rolling sleeve	O/L
Loading all parts	Manual
Attach care label	S/N/L/S
1st shoulder join	O/L
Neck piping	FTLK(F/B)
2nd shoulder join	O/L
2nd shoulder point tack	S/N/L/S
Neck point tack	S/N/L/S
Sleeve join x 2	O/L
Prepare main & size label	S/N/L/S
Marking at the center back	Manual
Join main label	S/N/L/S
Side seam x 2	O/L
Sleeve chap tack x 2	S/N/L/S
Neck chap tack	S/N/L/S
Remove sticker	Manual
Turn over body	Manual
Bottom hem	FTLK(COM)

3.10.1. SMV calculation

Loading parts:

Observe time = $\frac{\text{C} \quad \text{ti}}{\text{N} \quad \text{o c}}$

$= \frac{1\ .7\ +2\ .9\ +2\ .3\ +1\ .0\ +1\ .2\ +1\ .1\ +1\ .2\ +1\ .3\ +1\ .3\ +1\ .2}{1}$

$= \frac{1\ \ .1}{1}$

= 15.71

Basic time = Observe time X rating

= 15.71 x 0.7

= 10.99

∴SMV = $\frac{\text{B} \quad \text{ti} \quad +(\text{B} \quad \text{ti} \quad \text{x Al} \quad)}{6}$

$= \frac{1\ .9\ \ +(1\ .9\ \ \text{x}\ 0.1\ )}{6}$

= 0.21

Sleeve rolling:

Observe time = $\frac{1\ .9\ +1\ .9\ +1\ .7\ +1\ .7\ +1\ .6\ +1\ .2\ +1\ .3\ +1\ .9\ +1\ .9\ +1\ .0}{1}$

$= \frac{1\ \ .4}{1}$

= 13.44

Basic time = 13.44 x 0.75

= 10.08

∴SMV = $\frac{1\ .0\ \ +(1\ .0\ \ \text{x}\ 0.1\ )}{6}$

= 0.19

Attach care label:

Observe time = $\frac{8.7\ \ +1\ \ .0\ \ +1\ \ .8\ \ +1\ \ .1\ \ +1\ \ .1\ \ +9.3\ \ +1\ \ .0\ \ +8.4\ \ +1\ \ .9\ \ +1\ \ .8}{1}$

$=\frac{1\ \ \ .5}{1}$

= 10.25

Basic time = 10.25 x 0.75

= 7.69

∴SMV = $\frac{7.6\ \ \ +(7.6\ \ \ x\ 0.1\ \ )}{6}$

= 0.14

Shoulder joins:

Observe time = $\frac{1\ \ .8\ \ +1\ \ .0\ \ +1\ \ .3\ \ +1\ \ .3\ \ +1\ \ .6\ \ +2\ \ .9\ \ +1\ \ .9\ \ +1\ \ .1\ \ +1\ \ .2\ \ +1\ \ .4}{1}$

$=\frac{1\ \ \ .0}{1}$

= 17.80

Basic time = 17.80 x 0.70

= 12.46

∴SMV = $\frac{1\ \ .4\ \ +(1\ \ .4\ \ x\ 0.1\ \ )}{6}$

= 0.23

Neck piping:

Observe time = $\frac{1\ .7\ +1\ .7\ +1\ .5\ +1\ .9\ +1\ .9\ +1\ .8\ +1\ .5\ +1\ .2\ +1\ .5\ +1\ .9}{1}$

$= \frac{1\quad .4}{1}$

= 13.49

Basic time = 13.49x 0.70

= 9.44

∴SMV = $\frac{9.4\ \ +(9.4\ \ x\ 0.1\ \ )}{6}$

= 0.18

Neck point tack:

Observe time = $\frac{1\ .5+1\ .6\ +1\ .6\ +1\ .2\ +1\ .3\ +1\ .9\ +1\ .6\ +1\ .3\ +1\ .3\ +1\ .8}{1}$

$= \frac{1\quad .4}{1}$

= 11.74

Basic time = 11.74 x 0.75

= 8.80

∴SMV = $\frac{8.8\ \ +(8.8\ \ x\ 0.1\ \ )}{6}$

= 0.16

Cuff joins:

Observe time = $\frac{1\ .8\ +1\ .8\ +2\ .9\ +2\ .1\ +2\ .2\ +1\ .7\ +1\ +2\ .3\ +1\ .6\ +1\ .0}{1}$

$=\frac{1\ \ .8}{1}$

= 19.18

Basic time = 19.18 x 0.68

= 13.04

$\therefore$SMV = $\frac{1\ .0\ +(1\ .0\ \ x\ 0.1\ )}{6}$

= 0.24

Attach main label with size label:

Observe time = $\frac{8.0\ +8.7\ +7.7\ +9.1\ +6.7\ +7.1\ +1\ .1\ +8.5\ +7.5\ +8.5}{1}$

$=\frac{8\ .0}{1}$

= 8.20

Basic time = 8.20 x 0.70

= 5.74

$\therefore$SMV = $\frac{5.7\ +(5.7\ \ x\ 0.1\ )}{6}$

= 0.11

Marking at the center back:

Observe time = $\frac{5.1 \ +7.1 \ +8.5 \ +7.0 \ +8.0 \ +9.1 \ +6.1 \ +6.5 \ +7.5 \ +5.5}{1}$

$=\frac{7 \ .5}{1}$

= 7.05

Basic time = 7.05 x 0.65

= 4.58

∴SMV = $\frac{4.5 \ +(4.5 \ x\,0.1\ )}{6}$

= 0.08

Main label join:

Observe time = $\frac{2 \ .5 \ +2 \ .3 \ +2 \ .3 \ +2 \ .3 \ +2 \ .9 \ +1 \ .4 \ +2 \ .6 \ +2 \ .3 \ +2 \ .0 \ +2 \ .1}{1}$

$=\frac{2 \ \ .9}{1}$

= 22.92

Basic time = 22.92 x 0.65

= 14.89

∴SMV = $\frac{1 \ .8 \ +(1 \ .8 \ x\,0.1\ )}{6}$

= 0.28

Side seam x 2:

Observe time = $\frac{2\ \ .5\ \ +2\ \ .1\ \ +2\ \ +1\ \ .1\ \ +2\ \ .7\ \ +1\ \ .7\ \ +2\ \ .4\ \ +2\ \ .1\ \ +2\ \ .6\ \ +2\ \ .4}{1}$

$=\frac{2\ \ \ .8}{1}$

= 21.38

Basic time = 21.38 x 0.70

= 14.96

∴SMV = $\frac{1\ \ .9\ \ +(1\ \ .9\ \ \text{x}\ 0.1\ \ )}{6}$

= 0.28 x 2

= 0.56

Sleeve tack x 2:

Observe time = $\frac{5.5\ \ +7.1\ \ +8.7\ \ +5.4\ \ +8.2\ \ +6.0\ \ +5.5\ \ +5.5\ \ +6.1\ \ +6.0}{1}$

$=\frac{6\ \ .4}{1}$

= 6.44

Basic time = 6.44 x 0.75

= 5.15

∴SMV = $\frac{5.1\ \ +(5.1\ \ \text{x}\ 0.1\ \ )}{6}$

= 0.19

Neck chap tack:

Observe time = $\frac{5.2 \ +8.4 \ +8.8 \ +6.2 \ +6.8 \ +8.0 \ +9.0 \ +9.1 \ +5.8 \ +8.8}{1}$

$=\frac{7\ \ .3}{1}$

= 7.63

Basic time = 7.63 x 0.75

= 5.72

∴SMV = $\frac{5.7 \ \ +(5.7 \ \ x\,0.1 \ \ )}{6}$

= 0.10

Remove sticker:

Observe time = $\frac{1\ \ .0 \ +1\ \ .7 \ +9.4 \ +8.8 \ +7.7 \ +1\ \ .1 \ +1\ \ .1 \ +1\ \ .0 \ +1\ \ .1 \ +9.8}{1}$

$=\frac{9\ \ .1}{1}$

= 9.61

Basic time = 9.61 x 0.70

= 6.72

∴SMV = $\frac{6.7 \ \ +(6.7 \ \ x\,0.1 \ \ )}{6}$

= 0.12

Turn-over body:

Observe time = $\frac{6.7 \ +7.1 \ +7.4 \ +6.8 \ +6.6 \ +7.0 \ +6.8 \ +7.1 \ +7.4 \ +8.1}{1}$

=$\frac{7 \ .4}{1}$

= 7.14

Basic time = 7.14 x 0.68

= 4.85

∴SMV = $\frac{4.8 \ +(4.8 \ x\,0.1 \ )}{6}$

= 0.09

Bottom hem:

Observe time = $\frac{1 \ .4 \ +1 \ .7 \ +2 \ .3 \ +1 \ .5 \ +1 \ .2 \ +1 \ .3 \ +2 \ .9 \ +1 \ .4 \ +1 \ .0 \ +1 \ .8}{1}$

=$\frac{1 \ \ .9}{1}$

= 17.99

Basic time = 17.99 x 0.75

= 13.49

∴SMV = $\frac{1 \ .4 \ +(1 \ .4 \ x\,0.1 \ )}{6}$

= 0.25

Total SMV = 0.21+0.19+0.23+0.18+0.16+0.24+0.11+0.08+0.28+0.56+0.19+0.10+0.19+0.12+0.09+0.25

= 3.64

3.10.2. Line layout:

Description: Short sleeve round neck T-shirt

Fabric: Single jersey, 100% cotton, GSM-140

Operation name	**Machine type**	**M/C SMV**	**Mnl SMV**	**Tools**	**No. of threads**	**Thread color**	**IND target**	**O P/N**	**M/C Qty**	**Helper**
Rolling cuff	O/L	0.19		Pressure feed	2x2	DTM	315			
Loading all parts	Manual		0.21				285	1	1	1
Attach care label	S/N/L/S	0.14		Plain feed	1x1	DTM	428	1	1	
1st shoulder join	O/L	0.23		Pressure feed	2x2	DTM	260	1	1	
Neck piping	FTLK(F/B)	0.18		Folder	2x1	DTM	333	1	1	
2nd shoulder join	O/L	0.17		Pressure feed	2x2	DTM	352	1	1	
2nd shoulder point tack	S/N/L/S	0.09		Plain feed	1x1	DTM	666	1	1	
Neck point tack	S/N/L/S	0.16		Plain feed	1x1	DTM	375	1	1	
Cuff join x 2	O/L	0.48		Pressure feed	2x2	DTM	125	2	2	
Prepare main & size label	S/N/L/S	0.11		Plain feed	1x1	DTM	545	1	1	
Marking at the center back	Manual		0.08				750			
Join main label	S/N/L/S	0.28		Plain feed	1x1	DTM	215	1	1	
Side seam x 2	O/L	0.56		Pressure feed	2x2	DTM	108	2	2	
Sleeve chap tack x 2	S/N/L/S	0.19		Plain feed	1x1	DTM	315	1	1	
Neck chap tack	S/N/L/S	0.1		Plain feed	1x1		600	1	1	
Remove sticker	Manual		0.12				500			1
Turn over body	Manual		0.09				666			
Bottom hem	FTLK(COM)	0.26		Pressure feed	2x1	DTM	230	1	1	
	SMV	**3.14**	**0.5**				**Total**	16	16	2
	Total SMV	**3.64**					**Total man**	18		

3.10.3. Linetarget= $\frac{1 \quad x\, 6}{3.6}$

= 296pcs/day

3.10.4. Line production= 260pcs/day

3.10.5. Line deficiency= 296-260

= 36pcs/day

3.10.6.Line efficiency= 87%

3.10.7. Causes of line deficiency:

- ✓ Bottleneck process.
- ✓ Un- skill operator.
- ✓ More defects in garments.
- ✓ Lack of training to operator, supervisor etc.
- ✓ Improper line layout.
- ✓ No idea about production.

3.10.8. Reduction of line deficiency:

- ✓ Reduce bottleneck process.
- ✓ Provide training to operator.
- ✓ Improve garments quality.
- ✓ Proper line layout & balancing.

3.11. Operation breakdown: Leggings

Description: Leggings.

Fabric: Interlock fabric, 100% cotton, GSM-320.

Operation name	Machine name
Marking zipper place	Manual
Waist belt rib	Plain m/c
Yoke join	Over-lock
Loading all parts	Manual
Zipper tack	Plain m/c
Cut zipper mark place	Manual
Fix zipper into front part	Plain m/c
Attach zipper	Plain m/c
Zipper top stitch	Plain m/c
Pocket marking	Manual
Pocket attach	Plain m/c
Yoke top stitch	Flat bar flat lock m/c
Size label join	Plain m/c
Fly join	Over-lock
Side seam	Over-lock
Side seam top stitch	Flat bar flat lock m/c
In-seam	Over-lock
Back + Front rise join	Over-lock
Front rise top stitch	Cylinder bed flat lock m/c
Fly top stitch	Plain m/c
Belt join	Over-lock
Elastic tack with belt fabric	Plain m/c
Belt close	Plain m/c
Trimming waist belt	Over-lock
Loop making	Vertical plain m/c
Loop top stitch	Plain m/c
Button attach into loop	Eye- light m/c
Loop join	Plain m/c
Loop tack	Plain m/c
Attach main label	Plain m/c
Bottom hem	Plain m/c
Remove sticker + Turn over body	Manual

3.11.1. SMV calculation

Mark zipper place:

Observe time $=\frac{7.1 \;\; +6.8 \;\; +7.5 \;\; +6.3 \;\; +6.8 \;\; +8.4 \;\; +7.3 \;\; +6.4 \;\; +8.0 \;\; +1 \;\; .4}{1}$

$=\frac{7 \;\; .4}{1}$

$=7.64$

Basic time= 7.64 x 0.8

= 6.11

$\therefore$SMV $=\frac{6.1 \;\; +(6.1 \;\; \text{x} \; 0.1 \;\;)}{6}$

= 0.11

Waist belt rib:

Observe time $=\frac{1 \;\; .1 \;\; +8.3 \;\; +1 \;\; .8 \;\; +1 \;\; .0 \;\; +1 \;\; .9 \;\; +1 \;\; .0 \;\; +1 \;\; .6 \;\; +8.2 \;\; +1 \;\; .7 \;\; +1 \;\; .6}{1}$

$=\frac{1 \;\;\; .5}{1}$

$=11.75$

Basic time= 11.75 x 0.7

= 8.22

$\therefore$SMV $=\frac{8.2 \;\; +(8.2 \;\; \text{x} \; 0.1 \;\;)}{6}$

= 0.15

Yoke join x 2:

Observe time $=\frac{8.2 \;\; +7.4 \;\; +6.2 \;\; +7.5 \;\; +9.7 \;\; +7.1 \;\; +6.1 \;\; +7.5 \;\; +7.1 \;\; +6.3}{1}$

$=\frac{7 \;\; .7}{1}$

=7.37

Basic time= 7.37 x 0.8

= 5.89

∴SMV $=\frac{5.8 \;\; +(5.8 \;\; \text{x } 0.1 \;\;)}{6}$

= 0.11 x 2

= 0.22

Loading all parts:

Observe time $=\frac{7.9 \;\; +7.5 \;\; +1 \;\; .9 \;\; +7.7 \;\; +7.6 \;\; +7.2 \;\; +1 \;\; .5 \;\; +7.9 \;\; +1 \;\; .6 \;\; +9.3}{1}$

$=\frac{9 \;\; .7}{1}$

=9.37

Basic time= 9.73 x 0.7

= 6.56

∴SMV $=\frac{6.5 \;\; +(6.5 \;\; \text{x } 0.1 \;\;)}{6}$

= 0.12

Zipper tack:

Observe time $=\frac{3.8 \ +2.7 \ +3.3 \ +3.5 \ +2.2 \ +3.0 \ +3.0 \ +2.6 \ +4.8 \ +3.4}{1}$

$=\frac{3 \ .6}{1}$

=3.26

Basic time= 3.26 x 0.85

= 2.77

∴SMV $=\frac{2.7 \ +(2.7 \ \ x\, 0.1 \ )}{6}$

= 0.05

Cut zipper mark place:

Observe time $=\frac{4.1 \ +6.0 \ +6.8 \ +5.7 \ +5.1 \ +6.7 \ +7.6 \ +8.6 \ +4.6 \ +6.1}{1}$

$=\frac{6 \ .5}{1}$

=6.15

Basic time= 6.15 x 0.75

= 4.61

∴SMV $=\frac{4.6 \ \ +(4.6 \ \ x\, 0.1 \ )}{6}$

= 0.08

Fix zipper into front part:

Observe time $= \frac{9.7 \ +1 \ .1 \ +1 \ .3 \ +7.0 \ +1 \ .7 \ +7.9 \ +1 \ .2 \ +9.5 \ +8.7 \ +9.3}{1}$

$= \frac{9 \ .7}{1}$

$=9.57$

Basic time= 9.57 x 0.75

= 7.17

$\therefore$SMV $= \frac{7.1 \ +(7.1 \ \text{x}\ 0.1 \ )}{6}$

= 0.13

Attach zipper:

Observe time $= \frac{2 \ .1 \ +2 \ .9 \ +2 \ .7 \ +2 \ .9 \ +2 \ .1 \ +2 \ .1 \ +2 \ .7 \ +2 \ .5 \ +2 \ .7 \ +2 \ .2}{1}$

$= \frac{2 \ \ .3}{1}$

$=25.33$

Basic time= 25.33 x 0.7

= 17.73

$\therefore$SMV $= \frac{1 \ .7 \ +(1 \ .7 \ \text{x}\ 0.1 \ )}{6}$

= 0.33

Zipper top seam:

Observe time $= \frac{1\ .5\ +1\ .1\ +2\ .6\ +1\ .5\ +1\ .6\ +1\ .1\ +1\ .7\ +1\ .2\ +1\ .2\ +1\ .1}{1}$

$= \frac{1\ \ .0}{1}$

$=16.80$

Basic time= 16.80 x 0.75

= 12.60

$\therefore$SMV $= \frac{1\ .6\ +(1\ .6\ \ x\,0.1\ )}{6}$

= 0.24

Pocket marking x 2:

Observe time $= \frac{7.1\ +8.3\ +1\ .9\ +9.6\ +1\ .2\ +1\ .0\ +1\ .1\ +1\ .3\ +9.0\ +1\ .0}{1}$

$= \frac{9\ .0}{1}$

$=9.80$

Basic time= 9.80 x 0.7

= 6.86

$\therefore$SMV $= \frac{6.8\ +(6.8\ \ x\,0.1\ )}{6}$

= 0.13 x 2

= 0.26

Attaching pocket x 2:

Observe time = $\frac{1\ .7\ +1\ .3\ +1\ .0\ +1\ .3\ +1\ ,2\ +1\ .7\ +1\ .4\ +1\ .4\ +1\ .3\ +1\ .7}{1}$

$=\frac{1\quad .5}{1}$

=12.85

Basic time= 12.85 x 0.75

= 9.63

∴SMV =$\frac{9.6\quad +(9.6\ \ x\ 0.1\ \ )}{6}$

= 0.18 x 2

= 0.36

Pocket closing x 2:

Observe time =$\frac{1\ .6\ +1\ .2\ +7.2\ +8.1\ +1\ .4\ +8.5\ +9.7\ +1\ .3\ +9.4\ +8.1}{1}$

$=\frac{9\ .8}{1}$

=9.88

Basic time= 9.88 x 0.7

= 7.41

∴SMV =$\frac{7.4\ +(7.4\quad x\ 0.1\ \ )}{6}$

= 0.14 x 2

=0.28

Yoke top seam x 2:

Observe time $=\frac{1\ \ .9\ +6.1\ +7.2\ +7.5\ +5.5\ +6.1\ +7.2\ +1\ \ .7\ +6.5\ +6.2}{1}$

$=\frac{6\ \ .5}{1}$

=6.45

Basic time= 6.45 x 0.80

= 5.16

∴SMV $=\frac{5.1\ \ +(5.1\ \ \ x\ 0.1\ \ )}{6}$

= 0.09 x 2

=0.19

Size label join:

Observe time $=\frac{2\ \ .6\ +1\ \ .8\ +1\ \ .2\ +1\ \ .2\ +1\ \ .6\ +1\ \ .1\ +2\ \ .5\ +1\ \ .9\ +1\ \ .8\ +2\ \ .0}{1}$

$=\frac{1\ \ \ \ .1}{1}$

=19.01

Basic time= 19.01 x 0.7

= 13.30

∴SMV $=\frac{1\ \ .3\ \ \ +(1\ \ .3\ \ \ x\ 0.1\ \ )}{6}$

= 0.25

Fly join:

Observe time $=\frac{1\ .7\ +1\ .6\ +1\ .9\ +1\ .6\ +1\ .2\ +1\ .6\ +1\ .7\ +1\ .6\ +1\ .7\ +1\ .7}{1}$

$=\frac{1\ \ .6}{1}$

$=13.66$

Basic time= 13.66 x 0.80

= 10.93

∴SMV $=\frac{1\ .9\ \ +(1\ .9\ \ x\,0.1\ )}{6}$

= 0.20

Side seam:

Observe time $=\frac{5\ .0\ +4\ .4\ +4\ .9\ +3\ .1\ +5\ .6\ +4\ .9\ +3\ .2\ +5\ .2\ +3\ .0\ +4\ .0}{1}$

$=\frac{4\ \ .5}{1}$

$=45.26$

Basic time= 45.26 x 0.7

= 33.94

∴SMV = $\frac{3\ .9\ \ +(3\ .9\ \ x\,0.1\ )}{6}$

= 0.65

Side top seam:

Observe time $=\frac{1\ .9\ +1\ .6\ +1\ .3\ +1\ .6\ +1\ .7\ +1\ .6\ +1\ .8\ +1\ .3\ +1\ .8\ +2\ .8\ +1\ .3}{1}$

$=\frac{1\quad .3}{1}$

$=18.43$

Basic time= 18.43 x 0.7

= 12.90

$\therefore$SMV $=\frac{1\ .9\ \ +(1\ .9\ \ x\,0.1\ )}{6}$

= 0.24

Inseam joins:

Observe time $=\frac{2\ .6\ +2\ .6\ +2\ .1\ +3\ .2\ +2\ .0\ +3\ .7\ +2\ .5\ +2\ .0\ +2\ .3\ +2\ .5}{1}$

$=\frac{2\quad .9}{1}$

$=26.50$

Basic time= 26.50 x 0.7

= 17.85

$\therefore$SMV $=\frac{1\ .8\ \ +(1\ .8\ \ x\,0.1\ )}{6}$

= 0.34

Back + front rise join:

Observe time= $\frac{2\ \ .5\ \ +2\ \ .0\ \ +2\ \ .7\ \ +2\ \ .2\ \ +2\ \ .5\ \ +2\ \ .8\ \ +1\ \ .6\ \ +2\ \ .9\ \ +2\ \ .6\ \ +2\ \ .7}{1}$

$=\frac{2\ \ \ .9}{1}$

=22.59

Basic time= 22.59 x 0.80

= 18.07

∴SMV = $\frac{1\ \ .0\ \ \ +(1\ \ .0\ \ x\ 0.1\ \ )}{6}$

= 0.34

Front rise top seam:

Observe time= $\frac{1\ \ .2\ \ +1\ \ .9\ \ +2\ \ .8\ \ +1\ \ .5\ \ =1\ \ .2\ \ +1\ \ .9\ \ +1\ \ .0\ \ +1\ \ .2\ \ =1\ \ .5\ \ +1\ \ .1}{1}$

$=\frac{1\ \ \ .7}{1}$

=16.97

Basic time= 16.97 x 0.75

= 12.72

∴SMV = $\frac{1\ \ .7\ \ +(1\ \ .7\ \ \ x\ 0.1\ \ )}{6}$

= 0.24

Fly top seam:

Observe time=$\frac{2\ .4\ +2\ .6\ +1\ .4\ +2\ .6\ +2\ .7\ +1\ .1\ +2\ .2\ +2\ .9\ +2\ .8\ +2\ .5}{1}$

=$\frac{2\ \ .5}{1}$

=20.95

Basic time= 20.95 x 0.7

= 15.71

∴SMV =$\frac{1\ .7\ +(1\ .7\ \mathrm{x}\ 0.1\ )}{6}$

= 0.30

Waist belt join:

Observe time=$\frac{4\ .4\ +4\ .1\ +5\ .8\ +5\ .2\ +4\ .3\ +4\ .1\ +5\ .9\ +4\ .7\ +4\ .7\ +4\ .2}{1}$

=$\frac{4\ \ .9}{1}$

=48.89

Basic time= 48.89 x 0.7

= 34.22

∴SMV =$\frac{3\ .2\ +(3\ .2\ \mathrm{x}\ 0.1\ )}{6}$

= 0.65

Elastic tack:

Observe time= $\frac{6.8 \ +8.9 \ +6.6 \ +7.7 \ +6.8 \ +7.2 \ +8.5 \ +6.1 \ +7.2 \ +6.7}{1}$

$= \frac{7 \ .8}{1}$

=7.28

Basic time= 7.28 x 0.80

= 5.82

∴SMV = $\frac{5.8 \ +(5.8 \ \ x\, 0.1 \ )}{6}$

= 0.11

Elastic tack with waist belt fabric:

Observe time= $\frac{3 \ .5 \ +3 \ .0 \ +4 \ .3 \ +4 \ .8 \ +4 \ .0 \ +3 \ .0 \ +4 \ .0 \ +4 \ .8 \ +3 \ .8 \ +3 \ .0}{1}$

$= \frac{4 \quad .6}{1}$

=41.36

Basic time= 41.36 x 0.8

= 33.08

∴SMV = $\frac{3 \ .0 \ +(3 \ .0 \ \ x\, 0.1 \ )}{6}$

= 0.63

Waist belt close:

Observe time= $\frac{4\ \ .1\ \ +4\ \ .1\ \ +5\ \ .3\ \ +4\ \ .4\ \ +4\ \ .3\ \ +4\ \ .6\ \ +5\ \ .9\ \ +5\ \ .2\ \ +5\ \ .3\ \ +4\ \ .7}{1}$

= $\frac{4\ \ \ .2}{1}$

=48.32

Basic time= 48.32 x 0.7

= 33.82

∴SMV = $\frac{3\ \ .8\ \ +(3\ \ .4\ \ x\,0.1\ )}{6}$

= 0.64

Trimming waist belt:

Observe time = $\frac{3\ \ .3\ \ +2\ \ .2\ \ +1\ \ .4\ \ +3\ \ .8\ \ +3\ \ .3\ \ +2\ \ .9\ \ +3\ \ .3\ \ +2\ \ .7\ \ +2\ \ .8\ \ +2\ \ .0}{1}$

= $\frac{2\ \ \ .6}{1}$

=27.96

Basic time= 27.96 x 0.7

= 18.17

∴SMV = $\frac{1\ \ .1\ \ +(1\ \ .1\ \ x\,0.1\ )}{6}$

= 0.34

Loop making:

Observe time=$\frac{1\ .0\ +1\ .3\ +1\ .5\ +1\ .3\ +1\ .1\ +1\ .8\ +1\ .7\ +1\ .1\ +1\ .3\ +1\ .4}{1}$

=$\frac{1\quad .9}{1}$

=13.79

Basic time =13.79 x 0.7

= 11.03

∴SMV =$\frac{1\ .0\ +(1\ .0\ \ x\,0.1\ )}{6}$

= 0.21

Loop top seam:

Observe time=$\frac{1\ .5\ +1\ .7\ +1\ .1\ +1\ .5\ +1\ .8\ +1\ .6\ +9.9\ +1\ .3\ +1\ .1\ +1\ .5}{1}$

=$\frac{1\quad .4}{1}$

=11.54

Basic time= 11.54 x 0.8

= 9.23

∴SMV = $\frac{9.2\ \ +(9.2\ \ x\,0.1\ )}{6}$

= 0.17

Button attaching:

Observe time= $\frac{7.5\ +6.7\ +7.1\ +6.5\ +7.8\ +7.6\ +6.9\ +6.3\ +7.1\ +6.5}{1}$

$=\frac{7\ \ .4}{1}$

=7.04

Basic time= 7.04 x 0.8

= 5.63

∴SMV $=\frac{5.6\ \ +(5.6\ \ \text{x}\ 0.1\ \ )}{6}$

= 0.10

Loop joins:

Observe time= $\frac{1\ \ .6\ +9.1\ +1\ \ .4\ +1\ \ .2\ +1\ \ .6\ +1\ \ .0\ +1\ \ .6\ +9.1\ +1\ \ .0\ +1\ \ .3}{1}$

$=\frac{1\ \ \ .5}{1}$

=13.15

Basic time= 13.15 x 0.75

= 9.86

∴SMV $=\frac{9.8\ \ +(9.8\ \ \text{x}\ 0.1\ \ )}{6}$

= 0.18

Loop chap tack:

Observe time=$\frac{9.6\ \ +1\ \ .8\ \ +1\ \ .2\ \ +1\ \ .4\ \ +1\ \ .6\ \ +1\ \ .5\ \ +1\ \ .5\ \ +1\ \ .5\ \ +1\ \ .9\ \ +1\ \ .3}{1}$

=$\frac{1\ \ \ .7}{1}$

=12.97

Basic time= 12.97 x 0.7

= 9.07

∴SMV =$\frac{9.0\ \ \ +(9.0\ \ \ x\ 0.1\ \ )}{6}$

= 0.17

Loop tack:

Observe time=$\frac{1\ \ .9\ \ +1\ \ .6\ \ +1\ \ .8\ \ +1\ \ .9\ \ +1\ \ .2\ \ +1\ \ .0\ \ +1\ \ .0\ \ +1\ \ .2\ \ +1\ \ .8\ \ +1\ \ .6}{1}$

=$\frac{1\ \ \ .4}{1}$

=12.74

Basic time= 12.74 x 0.7

= 9.56

∴SMV =$\frac{9.5\ \ \ +(9.5\ \ \ x\ 0.1\ \ )}{6}$

= 0.18

Attach main label:

Observe time= $\frac{1\ .1\ +1\ .8\ +1\ .1\ +1\ .4\ +1\ .5\ +1\ .0\ +1\ .6\ +2\ .2\ +2\ .4\ +1\ .0}{1}$

$= \frac{1\quad .5}{1}$

$=16.05$

Basic time= 16.07 x 0.8

= 12.84

$\therefore$SMV = $\frac{1\ .8\ \ +(1\ .8\ \ x\,0.1\ )}{6}$

= 0.24

Bottom hem:

Observe time = $\frac{2\ .7\ +2\ .9\ +2\ .1\ +2\ .2\ +2\ .0\ +2\ .2\ +1\ .0\ +1\ .7\ +1\ .1\ +1\ .0}{1}$

$= \frac{2\quad .3}{1}$

$=20$

Basic time= 20 x 0.8

= 16.02

$\therefore$SMV = $\frac{1\ .0\ \ +(1\ .0\ \ x\,0.1\ )}{6}$

= 0.30

Total SMV :
0.11+0.15+0.22+0.12+0.05+0.08+0.13+0.33+0.24+0.26+0.28+0.19+0.25+0.20+0.65+0.24+0.36+0.34+0.24+0.30+0.65+0.11+0.63+0.64+0.34+0.21+0.17+0.10+0.18+0.17+0.18+0.24+0.30

= 8.65

3.11.2. Line layout

Description: Leggings.

Fabric: Interlock fabric, 100% cotton, GSM-320.

N0	Operation name	Machine name	M/c SMV	Mnl SMV	Tools	No. of thread	Thread color	Ind. Target	OP/NO	M/c Qty	Helper
1	Marking zipper place	Manual		0.11				545			1
2	Waist belt rib	Plain m/c	0.15		Plain feed	1x1	DTM	400	1	1	
3	Yoke join	Over-lock	0.22		Pressure feed	2x2	DTM	272	1	1	
4	Loading all parts	Manual		0.12				500			1
5	Zipper tack	Plain m/c	0.05		Plain feed	1x1	DTM	1200	1	1	
6	Cut zipper mark place	Manual		0.08				750			
7	Fix zipper into front part	Plain m/c	0.13		Plain feed	1x1	DTM	460			
8	Attach zipper	Plain m/c	0.33		Plain feed	1x1	DTM	181	1	1	
9	Zipper top stitch	Plain m/c	0.24		Plain feed	1x1	DTM	250	1	1	
10	Pocket marking	Manual		0.26				230			
11	Pocket attach	Plain m/c	0.36		Plain feed	1x1	DTM	167	1	1	
12	Yoke top stitch	Flat bar flat lock m/c	0.19		Pressure feed	2x1	DTM	315	1	1	
13	Size label join	Plain m/c	0.25		Plain feed	1x1	DTM	240			
14	Fly join	Over-lock	0.2		Pressure feed	2x2	DTM	300	1	1	
15	Side seam	Over-lock	0.65		Pressure feed	2x2	DTM	92	2	2	
16	Side seam top stitch	Flat bar flat lock m/c	0.24		Pressure feed	2x1	DTM	250	2	2	

17	In-seam	Over-lock	0.34		Pressure feed	2x2	DTM	176	1	1	
18	Back + Front rise join	Over-lock	0.34		Pressure feed	2x2	DTM	176	1	1	
19	Front rise top stitch	Cylender flat lock m/c	0.24		Pressure feed	2x1	DTM	250	1	1	
20	Fly top stitch	Plain m/c	0.3		Plain feed	1x1	DTM	200	1	1	
21	Belt join	Over-lock	0.65		Pressure feed	2x2	DTM	92	2	2	
22	Elastic tack with belt fabric	Plain m/c	0.63		Plain feed	1x1	DTM	95	2	2	
23	Belt close	Plain m/c	0.64		Plain feed	1x1	DTM	93	2	2	
24	Trimming waist belt	Over-lock	0.34		Pressure feed	2x2	DTM	176	1	1	
25	Loop making	Vertical plain m/c	0.21		Plain feed	1x1	DTM	285	1	1	
26	Loop top stitch	Plain m/c	0.17		Plain feed	1x1	DTM	352	1	1	
27	Button attach into loop	Eyelight m/c	0.1		Plain feed	1x1	DTM	600	1	1	
28	Loop join	Plain m/c	0.18		Plain feed	1x1	DTM	333	1	1	
29	Loop tack	Plain m/c	0.17		Plain feed	1x1	DTM	352	1	1	
30	Attach main label	Plain m/c	0.24		Plain feed	1x1	DTM	250	1	1	
31	Bottom hem	Plain m/c	0.3		Plain feed	1x1	DTM	200	1	1	
32	Remove sticker + Turn over body	Manual		0.22				272			1
		SMV	7.86	0.79				Manpower	30		3
		Total SMV	8.65					Total man	33		

3.11.3. Line target= $\frac{3 \quad x\,6}{8.6}$

= 228pcs/day

3.11.4. Line production= 175pcs/day

3.11.5. Line deficiency= 228-175

= 53pcs/day

3.11.6. Line efficiency= 76%

3.12. Operation breakdown: Ladies skirt

Description: Ladies skirt.

Fabric: Interlock fabric, 70% cotton + 30 % viscose, GSM-320.

Operation name	Machine type
Loading all parts	Manual
Attach care label	S/N/L/S
Side seam	O/L
Cut elastic	Manual
Elastic tack	S/N/L/S
Rib tack	S/N/L/S
Elastic tack with fabric(4)	S/N/L/S
Rolling waist belt	S/N/L/S
Attach waist belt	S/N/L/S
Join main label	S/N/L/S
Attach hanger loop	S/N/L/S
Remove sticker	Manual
Turn over body	Manual
Bottom hem	FTLK(COM)

3.12.1. Line layout

Description: Ladies skirt.

Fabric: Interlock fabric, 70% cotton + 30 % viscose, GSM-320.

Operation name	**Machine type**	**M/C SMV**	**Mnl SMV**	**Tools**	**No. of threads**	**Thread color**	**IND target**	**OP/N**	**M/C Qty**	**Helper**
Loading all parts	Manual		0.10				600			1
Attach care label	S/N/L/S	0.21		Plain feed	1x1	DTM	285	1	1	
Side seam	O/L	0.43		Pressure feed	2x2	DTM	140	2	2	
Cut elastic	Manual		0.09				667			1
Elastic tack	S/N/L/S	0.18		Plain feed	1x1	DTM	333	1	1	
Rib tack	S/N/L/S	0.18		Plain feed	1x1	DTM	333	1	1	
Elastic tack with fabric(4)	S/N/L/S	0.76		Plain feed	1x1	DTM	78	5	5	
Rolling waist belt	S/N/L/S	0.37		Plain feed	1x1	DTM	162	2	2	
Attach waist belt	S/N/L/S	0.85		Plain feed	1x1	DTM	70	3	3	
Join main label	S/N/L/S	0.25		Plain feed	1x1	DTM	240	1	1	
Attach hanger loop	S/N/L/S	0.37		Plain feed	1x1	DTM	162	2	2	
Remove sticker	Manual		0.08				750			1
Turn over body	Manual		0.09				667			
Bottom hem	FTLK(COM)	0.19		Pressure feed	2x1	DTM	315	1	1	
	SMV	**3.79**	**0.36**				**Total**	19	19	3
	Total SMV	**4.15**					**Total man**	22		

3.12.2. Line target=$\frac{2 \quad x\,6}{4.1}$
= 318pcs/day

3.12.3. Line production= 247pcs/day

3.12.4. Line deficiency= 318-247
= 71pcs/day

3.12.5. Line efficiency= 77%

3.13. Operation breakdown: Short sleeve V-neck polo shirt

Description: Short sleeve V-neck polo shirt.

Fabric: Rib fabric, 100% cotton, GSM-180.

S.N	Operation name	Machine
1	Loading parts	Manual
2	Sleeve hem	Compressor flat lock m/c
3	Pocket hem	Cylinder flat lock m/c
4	Attach label	Plain m/c
5	Placket rolling	Plain m/c
6	Placket join	Plain m/c
7	Placket top seam	Plain m/c
8	Shoulder join	Over lock
9	Sleeve join	Over lock
10	Collar tack	Plain m/c
11	Collar join	Over lock
12	Collar top seam	Plain m/c
13	Placket box making	Plain m/c
14	Pocket join	Plain m/c
15	Sleeve + Body side seam	Over lock
16	Bottom hem	Compressor flat lock m/c
17	Button hole	Button holding m/c
18	Button attach	Button attaching m/c

3.14. Operation breakdown: Basic T-shirt

Description: Basic T-shirt.

Fabric: Single jersey fabric, 100% cotton, GSM-140.

S.N	Operation name	Machine name
1	Sleeve side join	Over-lock m/c
2	Loading all parts	Manually
3	Attach care label	Plain m/c
4	Shoulder join	Over-lock m/c
5	Neck piping	Flat bar plat lock m/c
6	2nd shoulder join	Over-lock m/c
7	Attach main + size label	Plain m/c
8	Side join	Over-lock m/c
9	Sleeve join	Over-lock m/c
10	Sleeve hem	Cylinder bed flat lock m/c
11	Body hem	Compressor flat lock m/c

3.15. Operation breakdown: Ten top

Description: Ten top.

Fabric: Single jersey fabric, 100% cotton, GSM-120.

S.N	Operation breakdown	Machine name
1	Loading back and front parts	Manually
2	Shoulder join	Over-lock m/c
3	Neck piping	Over-lock m/c
4	Back neck tip piping	Flat bar flat lock m/c
5	Neck top stitch	Plain m/c
6	2nd shoulder join	Over-lock m/c
7	Arm hole piping	Over-lock m/c
8	Arm hole top stitch	Cylinder bed flat lock m/c
9	Attach care and size label	Plain m/c
10	Side join	Over-lock m/c
11	Bottom hem	Compressor flat lock m/c

3.16. Operationbreakdown: Ladies pant

Description: Ladies pant.

Fabric: Denim knit fabric, 100% cotton, GSM-160.

S.N	Operation breakdown	Machine name
1	Belt side join	Plain m/c
2	Yoke join	Over-lock m/c
3	Loading all parts	Manually
4	Zipper join	Plain m/c
5	Zipper top stitch	Plain m/c
6	Pocket join	Plain m/c
7	Yoke top stitch	2N Flat lock m/c
8	Join care & size label	Plain m/c
9	Front rise + Fly join	Over-lock m/c
10	Side join	Over-lock m/c
11	Side top stitch	Flat bar flat locl m/c
12	In-seam join	Over-lock m/c
13	Back rise join	Over-lock m/c
14	Front rise top stitch	Cylinder bed flat lock m/c
15	Fly top stitch	Plain m/c
16	Belt join	Over-lock m/c
17	Elastic prepare & tack	Plain m/c
18	Elastic attach with belt fabric	Plain m/c
19	Belt close	Over-lock m/c
20	Loop making	Plain m/c
21	Loop top stitch	Plain m/c
22	Attach flap button on the loop	Eye light m/c
23	Loop join	Plain m/c
24	Attach main label into waist band	Plain m/c
25	Leg hemming	Plain m/c

3.17. Thread consumption for garments

Procedure:

- ✓ Sew a seam of 12 cm long and take 10 cm seam out of it by trimming 1 cm from both edges.
- ✓ Unravel both needle and bobbin thread.
- ✓ Straight the thread and measure its length.
- ✓ Find multiplying factor by dividing thread length with seam length.
- ✓ When you will get thread consumption factor then it will be easy to calculate total thread consumption of a garments.
- ✓ So measure seam length of all operations of the garments and get thread requirement by multiplying thread consumption factor by adding 5% wastage.

Example:

For a T-shirt:

Suppose for making a basic T-shirt we normally use plain machine of 20cm (Attaching label), flat machine 164cm (Bottom hem 104cm + Sleeve hem 64cm) and over-lock machine 296cm (Sleeve join 96cm, side seam 140cm and shoulder join 60cm) so find out the total thread?

Solution:

Plain m/c:

We have sewn 12cm & take 10cm seam .After straight we get the total length of 14cm. So the multiplying factor is;

Multiplying factor = $\frac{1}{1}$ = 1.4

So plain m/c thread consumption = 20 x 1.4 = 28cm

Flat lock m/c:

We have sewn 12cm & take 10cm seam .After straight we get the total length of 25cm. So the multiplying factor is;

Multiplying factor = $\frac{2}{1}$ = 2.5

So flat lock m/c thread consumption = 164 x 2.5 = 410cm

Over-lock machine:

We have sewn 12cm & take 10cm seam .After straight we get the total length of 20cm. So the multiplying factor is;

Multiplying factor = $\frac{2}{1}$ = 2

So over- lock m/c thread consumption = 296 x 2 = 592cm

Total thread consumption = 28 +410+592

=1030

= 1030 + 1030 x 0.05

= 1030 + 51.5

= 1081.5cm

= 11m

4. DISCUSSION

During our project we have analysis on the result previous sewing line where there is no industrial engineer and another is recent sewing line where operation breakdown, line layout, line balancing everything done by industrial engineer. We can see in recent sewing line efficiency is higher than previous sewing line where there is no industrial engineer. During our project we have done different styles operation breakdown such as T-shirt, leggings, ladies pant, ten top skirts, calculating their SMV, target, line efficiency etc. We have calculated SMV of narrow neck round T-shirt is 3.64, line efficiency 87% and line deficiency is 36pieces per day. We have also calculated the SMV of legging is 8.96, line efficiency 76% and line deficiency is 53 pieces per day.We have also calculated the SMV of ladies skirt is 4.15, line efficiency 77% and line deficiency is 71 pieces per day.

5.CONCLUSION

Finally we can say that after completing this thesis we can learn something about industrial engineering. We can compare where industrial engineer is present and where there is no industrial engineer by theirproduct quality and line efficiency. We think that as our apparel industry is identified as a buyer-driven or customer driven industry, so the apparel production has become more intensified by global competition. To survive in this competitive world the industry should work more efficiently. The concepts which are outlined here are the most important factors to improve the productivity and efficiency of the industry. The application of industrial engineering method like, work study, capacity study, line layout and other operations management systems are ultimately leads the industry to timely delivery of goods, high profit & develop the working environment as a happy place.

REFERENCE

- ✓ http://textilelearner.blogspot.com/application-of-industrial-engineering.html
- ✓ http://www.textilehelpline.com/concept-of-industrial-engineering
- ✓ All industrial information collected from H.R TEXTILE MILLS LTD.